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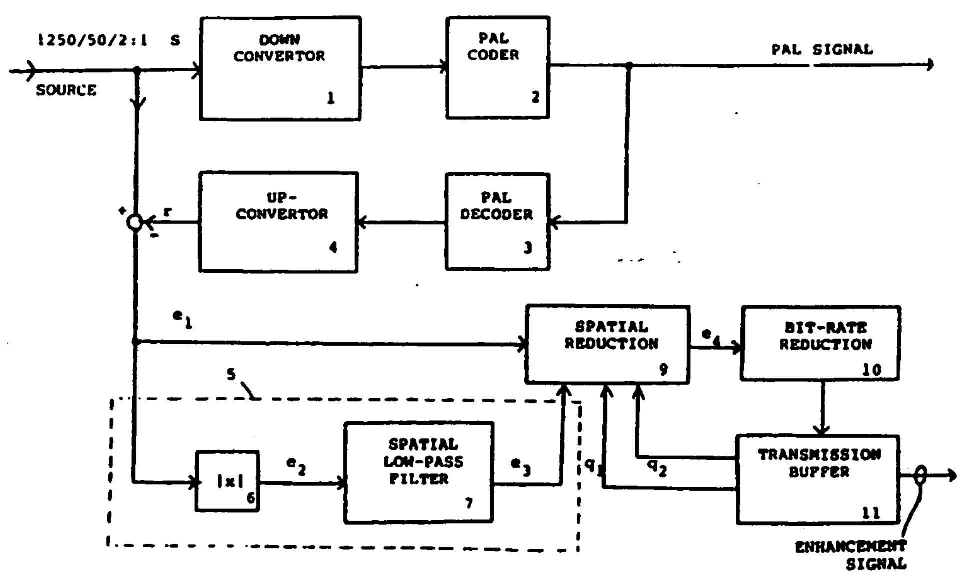

(57) Abstract

The amount of high frequency variation, horizontally and/or vertically, which is in a video image is evaluated by processing a video signal representing the image so as to produce a lower definition version thereof, reconstructing the video signal from the lower definition version, subtracting the reconstructed signal from the original signal to produce an error signal and low pass filtering the modulus of the error signal. The resultant signal is indicative of the amount of detail in the video image and, for example, may be used, in a system where a high definition image signal is conveyed by the combination of a low definition signal (compatible with conventional receivers) and an error signal, to decide whether or not to transmit the error signal in respect of a particular part of the video image.

Evaluation of detail in video images, and applications thereof

The present invention relates to evaluation of the amount of spatial detail (high frequency variation horizontally and/or vertically) present in video images and to applications of the result of the evaluation. In particular, the invention relates to the making and the use of such an evaluation in relation to video signals comprising an image signal and an enhancement signal.

In the field of high definition television, proposals have been made for the transmission of the high definition image information in the form of a basic image signal accompanied by an enhancement signal. Such an arrangement is designed to be compatible with existing television receivers which would produce a picture using the basic image signal alone.

When dealing with video signals of a type comprising an image signal and an enhancement signal (which may be used in combination to produce an overall image) it can be useful, for a variety of applications, to know in which areas of the picture there is detail, ie high frequency spatial variation.

The present invention provides an evaluation of the high frequency spatial variation in an image represented by a video signal by processing an enhancement signal forming part of the video signal.

enhance; the enhancement signal is modified so as to include full enhancement information only in relation to these more important areas.

Further features and advantages of the present invention will become clear from the following detailed description of embodiments thereof, given by way of example, with reference to the accompanying drawings in which:

Figure 1 shows in block diagrammatic form a transmitter of a system for selective enhancement of PAL signals using the evaluation technique according to the invention; and

Figure 2 shows in block diagrammatic form a receiver compatible with the transmitter of Figure 1.

The following description, given in relation to figures 1 and 2, relates to the application of the evaluation technique of the present invention in a system for selective enhancement of PAL television signals. As mentioned above, the aim of the system is to fully enhance only those parts of the picture which tend to have the biggest impact as far as picture quality is concerned, but not others. The difficulty is to decide which parts of the picture are important and which are not. It is considered important, for example, to enhance an entire object if it contains a significant amount of detail whereas picture areas with low detail density need not be enhanced at all. Furthermore, once the enhancement signal is applied to a certain object, this object should continue to be enhanced even if it starts to move. Thus the algorithm described below produces clusters of enhancement, with areas in between which are not enhanced.

Figure 1 shows a block diagram of a transmitter in a PAL-compatible high definition television system according to an embodiment of the

before coding and transmission, so as to include full enhancement information only in relation to those parts of the image which have greatest high frequency spatial variation.

The evaluation of the degree of high frequency detail in the image is made in the circuitry 5 marked with dashed lines in figure 1. First the magnitude of the initial enhancement signal, e_1, is calculated in the device 6 to give an output, e_2, where:

$$e_2 = |e_1|$$

Subsequently the signal e_2 is spatially low-pass filtered to produce a signal e_3. This signal is indicative of the instantaneous high frequency detail in the image and is used in determining how the initial enhancement signal, e_1, is modified in a spatial reduction unit 9.

The size of the spatial low-pass filter 7 (ie the number of lines and pixels it covers) is more important than the detailed shape of the filter, (which is intended to provide a smooth transition between areas of little or no enhancement and neighbouring areas of full enhancement). Although other shapes are possible, for the selective enhancement system illustrated in Fig. 1 it is preferred to use a filter having a triangular shape, with a slope of about 10% per pixel (or vertically 10% per line) but truncated to 5 pixels (3 lines).

In order to ensure that the selection signal, e_3, indicative of high frequency detail in the image, is used by the spatial reduction unit 9 in relation to the appropriate portion of the enhancement signal, e_1, a compensatory delay (not shown) may be included in the path of the enhancement signal e_1 to the spatial reduction unit 9.

Since it is desired to transmit full

single bit, or a code, indicating "zero" block activity).

Preferably, as shown in Fig. 1, the two threshold levels, q_1 and q_2 used by the spatial reduction unit 9 are related to the fill level of the output (transmission) buffer 11.

Because the reduction of the enhancement signal is carried out at the transmitter, the high definition receiver complexity can be kept to a minimum, as shown in Figure 2.

In the simple high definition receiver of Figure 2 the PAL signal and enhancement signal portions are extracted from the received signal. The PAL signal is fed to a conventional PAL decoder 20 and the line rate of the decoded output is increased by using an upconvertor 21 (which may be of conventional type). The enhancement signal is loaded into a receiver buffer 23 and then into a bit rate expansion unit 24. The processed PAL and enhancement signals are combined in an adder 25 to produce an enhanced signal for display.

Application of the spatial reduction of the enhancement signal means that a simpler bit-rate compression algorithm can be used for the same level of enhancement. As an example, simulations have shown that spatial reduction followed by simple quantisation can achieve a picture quality which is at least as good as intra-field DCT on its own. Implementation of the selective enhancement circuit in the transmitter can, therefore, lead to a significant reduction of the complexity of receivers.

The method described above selectively enhances only certain parts of a picture. Simulations have shown that for realistic values of the two thresholds q_1 and q_2 the method can be used in conjunction with conventional image compression

directly, convey information about its level (eg one field in advance); or, for a relatively small variation in the level of the auxiliary signal, a form of automatic gain control may be used at the receiver (if the auxiliary signal conveys digital information then the effect of the resulting variation in its signal-to-noise ratio may be reduced, if necessary, using forward error correction).

In another embodiment, an error signal according to the invention may be produced to control the application of a non-linear signal enhancement process at the receiver. Again the error signal is used to reduce the enhancement process in picture areas with little or no detail (where the application of such an enhancement process would only produce "artefacts" or increase noise).

5. A method according to any one of claims 1 to4, wherein the filtering step comprises passing the error signal through a low pass filter having a frequency response which is triangular in shape.

6. A method according to claim 5, wherein the slope of the frequency response of the filter is of the order of 10% per pixel and/or, vertically, 10% per line, of the video image.

7. A method for processing a video signal, the method comprising the steps of:

evaluating, by the method according to any of claims 1 to 6, the amount of high frequency variation horizontally and/or vertically there is in a video image represented by the video signal;

outputting the basic video signal; and

comparing the filtered error signal with a first threshold level, q_1, outputting a signal related to the difference between the original video signal and the reconstructed signal when the magnitude of the filtered error signal exceeds said first threshold level, and outputting a zero signal when the filtered error signal is lower than the first threshold level, q_1.

8. A method according to claim 7, wherein the comparing step comprises comparing the filtered error signal with a second threshold level, q_2, outputting a signal which is a fraction of the difference between the original video signal and the reconstructed signal when the magnitude of the filtered error signal is between the first and second threshold levels, the size of the fraction being related to the ratio of the difference between the filtered error signal and the first threshold level, q_1, to the difference between the

definition than the original video signal;

means (3,4) for processing said basic video signal so as to substantially reconstruct the original video signal;

means for comparing the reconstructed signal (r) with the original video signal (s) so as to produce an error signal indicative of the difference therebetween; and

low pass filtering means (7) for filtering the error signal, whereby to produce a signal indicative of the amount of high frequency variation horizontally and/or vertically there is in the image represented by the original video signal.

12. Apparatus according to claim 11, wherein the comparing means comprises means (6) for taking the modulus of the difference between the original video signal (S) and the reconstructed signal (r).

13. Apparatus according to claim 11 or 12, wherein the filtering means (7) is adapted to operate over 5 pixels of the video image.

14. Apparatus according to claim 11, 12 or 13, wherein the filtering means is adapted to operate over 3 lines of the video image.

15. Apparatus according to any one of claims 11 to 14, wherein the filtering means (7) has a frequency response which is triangular in shape.

16. Apparatus according to claim 15, wherein the slope of the frequency response of the filtering means (7) is of the order of 10% per pixel and/or vertically 10% per line, of the video image.

of the difference between the original video signal and the reconstructed signal when the magnitude of the filtered error signal exceeds the second threshold level, q_2.

20. Apparatus according to claims 18 or 19, and further comprising means (10) for performing a bit rate reduction on the signal output by the comparing means, means for monitoring the bit rate of the signal output from the bit rate reduction means (10), and means for altering the threshold level or levels used by the comparing means dependent upon the magnitude of the monitored bit rate.

21. Apparatus for processing a video signal intended to be transmitted in the form of a main signal and an auxiliary signal modulated in quadrature with said main signal, the apparatus comprising:

apparatus according to any on of claims 11 to 17 for evaluating the amount of high frequency horizontal and/or vertical variation there is in a video image represented by the video signal; and

means for controlling the level of the auxiliary signal such that the level of the auxiliary signal is relatively high when the magnitude of the filtered error signal is relatively high, and the level of the auxiliary signal is relatively low when the magnitude of the filtered error signal is relatively low.

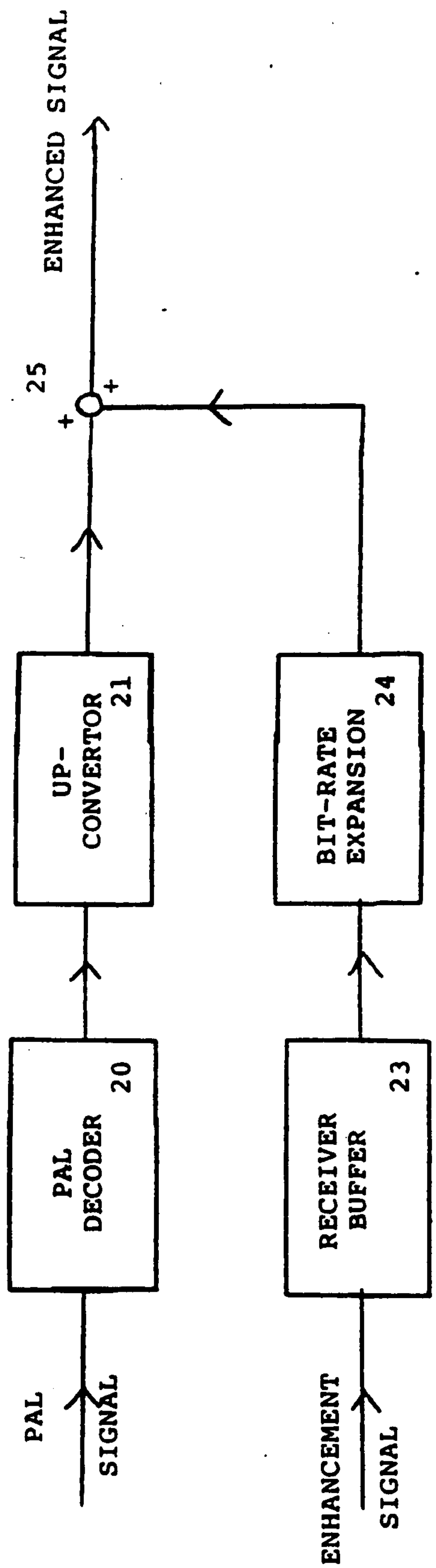
PAL SIGNAL
PAL DECODER 20
UP-CONVERTOR 21
25
ENHANCED SIGNAL
ENHANCEMENT SIGNAL
RECEIVER BUFFER 23
BIT-RATE EXPANSION 24

FIGURE 2

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	WO,A,8908366 (G.E.C.) 8 September 1989, see page 7, line 36 - page 8, line 9; page 40, line 8 - page 41, line 29 -----	1,11

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